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***Recent investigations into the stock composition of the Norwegian
and Russian coastal salmon fisheries (the Kolarctic salmon project)***

(Tabled by the Russian Federation)

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*Management of single and mixed stock fisheries, with particular focus
on fisheries on stocks below their conservation limits*

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***Recent investigations into the stock composition of the Norwegian and
Russian coastal salmon fisheries (the Kolarctic salmon project)***

Eero Niemelä¹, Vidar Wennevik², Juha-Pekka Vähä³, Mikhail Ozerov³, Rogelio Diaz
Fernandez³, Martin-A. Svenning⁴, Morten Falkegård⁴, Tiia Kalske⁵, Bente Christiansen⁵,
Elena Samoylova⁶ and Sergey Prusov⁶

¹*Finnish Game and Fisheries Research Institute (FGFRI), Finland*

²*Institute of Marine Research (IMR), Norway*

³*University of Turku (UTU), Finland*

⁴*Norwegian Institute of Nature Research (NINA), Norway*

⁵*County Governor of Finnmark (FMFI), Norway*

⁶*Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), Russia*

Introduction

Atlantic salmon (*Salmo salar* L.) exhibit a complex life history, in which the more commonly recognized form is anadromous, i.e. fish that spend their first years as juveniles in rivers and then migrate out in the ocean to grow and mature as an adult fish before migrating to their natal rivers for spawning (Mills 1989). Seawater migration is the key element in the life history of the Atlantic salmon. Mixed-stock fisheries on the migration routes pose a particular challenge for management, as they cannot distinguish between stocks that are at full reproductive capacity and those who are not.

A mixed stock Atlantic salmon fishery operates off the coast of northern Norway, in the three northernmost counties: Nordland, Troms and Finnmark. Average annual landings in the last 15-20 years have been close to 300 tonnes (Statistics Norway). Different salmon stocks from Norwegian, Finish and Russian rivers may migrate along the coastal areas at the time when the fishery operates. Tagging exercises in the past have showed that Atlantic salmon from Russian rivers migrate through the Barents and Norwegian Seas (Danilchenko, 1938; Bakshansky, 1970) and may be harvested along the North-Norwegian coastal line.

Due to strong homing, salmon inhabiting different rivers are reproductively isolated from each other and, therefore, the populations inhabiting different rivers have accumulated significant inter-population genetic variation which can be used to identify the river of origin of samples from coastal mixed-stock fishery. In 2010 the baseline for a number of Norwegian and Russian rivers were established through a pilot project to identify the origin of salmon in catches from coastal areas. The results from that project demonstrated that the GSI method could give reliable estimates of the proportion of salmon in the catches as well as estimates of how salmon from different regions and rivers were exploited in the coastal fisheries (Svenning et al. 2011). However, it was also recognized that the spatial coverage of the baseline should be expanded, the number of genetic markers should be increased, and additional sampling should be conducted in a number of salmon rivers to improve the precision of the assignment of individuals.

A further initiative to achieve this goal was taken by Norway, the Russian Federation and Finland. In 2011-2013 an EU project “Trilateral cooperation on our common resource; the Atlantic salmon in the Barents region” (the Kolarctic salmon project – KO197) was implemented. The project was supported by both EU-funding (Kolarctic ENPI CBC Programme) and national funding from Norway, the Russian Federation and Finland. The Kolarctic salmon project has generated one of the most comprehensive and detailed genetic datasets for any fish species. Results of genetic stock identification provide first and comprehensive overview to spatial and temporal variation in stock compositions in coastal fisheries of Northern Norway and in the White Sea. The data from the project will provide managers with tools for regulating fisheries on a more informed basis.

Genetic structure analyses

Genetic stock identification (GSI) has been used in salmon research and management over the last three decades allowing assessment of origin of the stocks being harvested. With the advent of powerful genetic markers, reduced costs of analysing large numbers of samples accompanied with the development of tailored statistical methods, genetic stock identification is one of the most successful biological tools available for assessing stock compositions in mixed stock fisheries. During the last decade it has become an indispensable and powerful tool to understand fishery dynamics, especially of salmonid fishes (Beacham et al. 2008, Hess et al. 2011).

The Kolarctic salmon project has generated one of the most comprehensive and detailed genetic datasets for any fish species. More than 13 000 individuals from over 200 samples collected from over 180 rivers in the Kolarctic area have been analysed for 31 DNA markers displaying well over 600 alleles (Vähä et al. 2014). Major genetic divisions were found at different geographical scales; the main genetic barrier appearing between the eastern populations of Russia, including the White Sea populations, and populations from northern Kola and northern Norway. Genetic barriers/shifts were also observed at finer geographic scales. Genetic differences between populations, overall and within a region, were greatest for the eastern populations of Russia. Genetic structuring within major river systems was observed in the Pechora, Ponoï and Teno rivers. In these river systems multiple populations exist and they should be managed as separate units. The genetic baseline developed for this project allows for precise identification of salmon caught at sea to individual rivers/reporting groups, providing opportunities for more adaptive and informed management of coastal salmon fisheries.

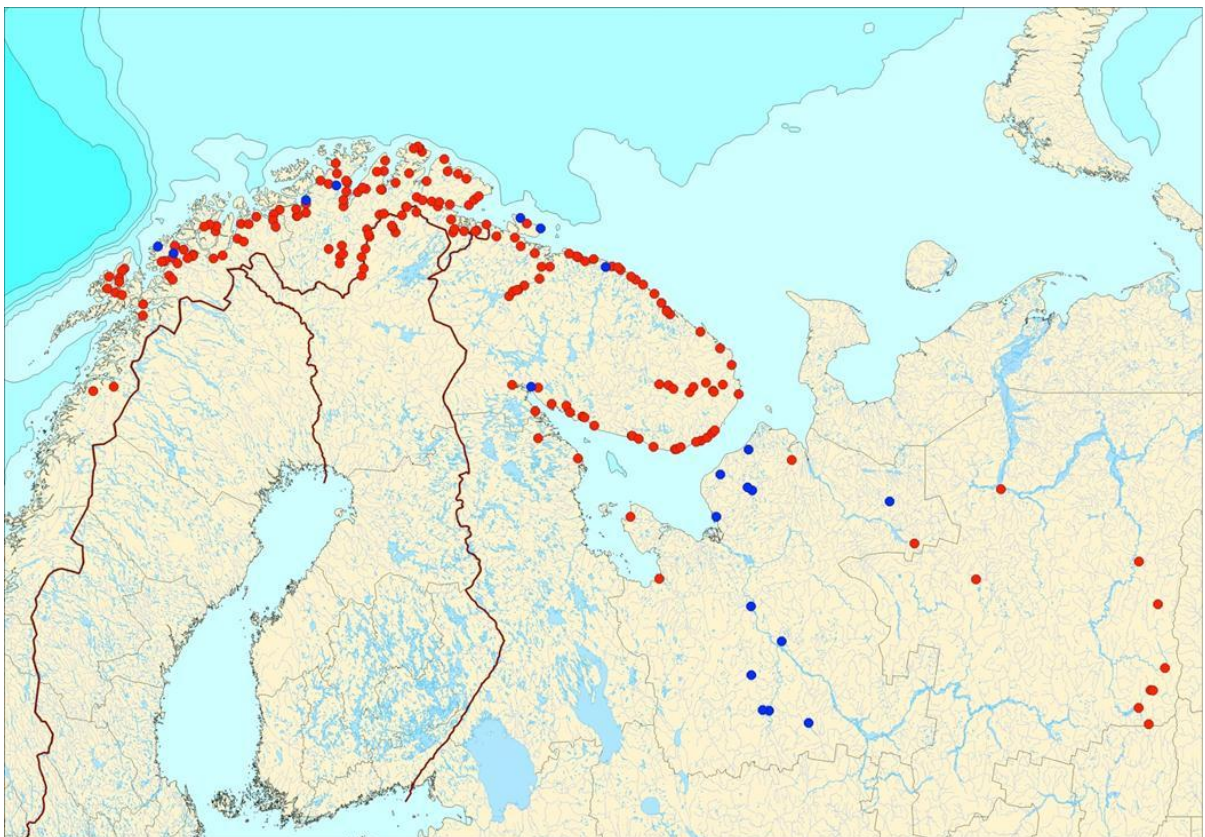


Figure 1 – A map showing rivers sampled for genetic dataset in the Kolarctic salmon project.

Genetic stock identification

The comprehensive sampling of adult Atlantic salmon along the North-Norwegian coast and in the White Sea was conducted in 2011 and 2012 through a very close collaboration between scientists and commercial fishermen. In total 17383 wild salmon were collected in the Norwegian coastal waters in May-September and 2058 salmon were sampled in the White Sea in June-December. To determine the river of origin of captured salmon, each fish was compared with genetic profiles of river stocks of nine reporting groups.

Power tests of genetic stock identification using test samples from the baseline data revealed large differences among rivers and regions in the expected level of stock identification. On average, 69% of samples assigned to a river were correct, but more than 70 stocks were distinguished and identified with high (>80%) assignment success to their river of origin. Highest correct assignment was observed for rivers in the Eastern Barents, in the White Sea and in the Teno River system salmon stocks (90%), while the lowest was observed for the Troms and Nordland stocks (54%).

Nine reporting groups, roughly following genetic boundaries, were delineated for identifying the geographical region of origin of salmon from coastal catches. Individuals from Russian rivers and Teno River system were correctly assigned to their respective reporting groups with 94-99% accuracy, while slightly lower assignment success was obtained for the samples from rivers in eastern and western Finnmark: 86%. Northern Troms and southern Troms reporting groups were combined, 80% of Troms salmon were correctly identified while salmon from rivers in Nordland had correct assignment of 72%.

Genetic stock identification analyses confirmed that coastal fisheries in northern Norway exploit multiple stocks. Altogether, 145 rivers were found to contribute to fishery samples. Fisheries generally exploited salmon from wide geographical areas with catch localities on the open coast showing greater stock diversity than catch localities within fjords. Fishery samples from May and June were composed of salmon from wider geographical areas, whereas samples from July and August were composed of more local populations. No adult salmon sampled in the White Sea were assigned to the rivers outside the area. Salmon caught in the White Sea originated from 25 rivers and a vast majority of fish was from 17 rivers of Murmansk region.

Genetic baseline developed in the Kolarctic salmon project allows for further studies of the marine distribution and exploitation of salmon from the Kolarctic area, such as mapping of migration of post-smolts and adults in the open sea, as well as identification of important genetic biodiversity units for conservation. Assignment accuracy and precision can be further increased by supplementing the baseline population data with more samples. With accumulating baseline data, genetic stock assignments assessed in the project can be refined, but the current data already provides valuable information on the stock compositions, harvest rates and migration patterns of salmon of the Barents Sea Region (Vähä et al., 2014).

Migration model

A stock-specific migratory model was developed for four large stocks, i.e. Målselv salmon in Troms county, Alta and Tana salmon in Finnmark county and Kola salmon in the Kola Peninsula, Russia (Svenning et al. 2014). All these stocks reached the North-Norwegian coast mainly in June-July, while MSW-salmon in general arrived earlier than 1SW-salmon.

The Målselv stock was mostly exploited around islands and coastlines in western Troms and close to the Malangen fjord system. Both MSW and 1SW Målselv salmon seem to reach the coast from the west, whereas MSW salmon reach the coast one month earlier. Thus, due to the coastal migration pattern of Målselv salmon, most sea fishery exploitation take place in inner part of Troms county, i.e. based on the strong regulations in salmon sea fishery in Troms, a relatively small fraction of the stock is exploited through the official sea fishery season.

The Alta stock seems to have a fairly similar migrating pattern as the Målselv stock, i.e. reaching the coast more or less from the west, and the dominant part of the stock is exploited within the Alta fjord. Still, due to their westward migration pattern, a relatively large fraction of the stock is also exploited by the salmon sea fishery in outer/northern Troms, and also in areas in western Finnmark, i.e. along the coast line west of Alta fjord. Based on the migration model, some of the 1SW salmon enters Alta fjord from the north, being slightly different compared to the MSW Alta stock. Although MSW Alta salmon reach the coast several weeks earlier than 1SW, MSW salmon was quite heavily exploited not only in late May and early June, but also in July and even in August. The Alta stock suffers a very high exploitation rate from the salmon sea fishery, especially within the Alta fjord in July and early August.

Tana salmon, as opposed to Målselv and Alta salmon, was recorded in the coastal catches from all fishing regions in the study area. Although the highest number of salmon (CPUE) was captured in the Tana fjord, the relatively high CPUE-values, both in southern Troms, as well as in western and eastern Finnmark strongly suggest that Tana salmon reach the coastal areas both from southwest, west, north and east.

Salmon originating from Russian rivers comprised more than 20% of the recorded catches. Still, the incidence of Russian salmon in the catches varied strongly within season and among fishing regions, being less than 9% in the coastal catches from Nordland, Troms, western Finnmark, mid Finnmark and the Tanafjord, while nearly 50% of all salmon captured in eastern Finnmark, mostly in Varangerfjord, had Russian origin. Further, the catch of Russian salmon decreased by time within season, and in eastern Finnmark the incidence of Russian salmon decreased from 70% in May to 20% in August. Thus, catches of Russian salmon were much higher before the start of official fishing season in eastern Finnmark, but, still a fairly large amount of the recorded catch in this area consisted of salmon stocks originated from Russian rivers.

Kola salmon, both 1SW and MSW, was most frequently recorded in catches in Eastern Finnmark, i.e. especially in Varangerfjord, whereas some Kola salmon were caught in western Finnmark in very early season. This may indicate that most Kola salmon reached the coast in Eastern Finnmark, whereas some fishes migrated from the west, but fairly far from the North-Norwegian coastal areas. The CPUE-values of MSW Kola salmon in Varangerfjord was highest in June/July, while Kola salmon was more or less absent in catches from early August and onwards.

Origin of catches during the official fishing time

Salmon catches during the official fishing time consisted of fish from a large geographical area especially in Troms and Finnmark counties. In Finnmark the official fishing time was covering period from June 1 to August 4 with many spatial and temporal differences between municipalities and therefore the origin of salmon in the catches was covering more precisely salmon stocks occurring in Kolarctic area than catches caught with much more limited fishing

time in Troms County or in Nordland County where the official fishing took place during six-eight days in three -four weeks' time in July.

In 2011 and 2012 in Finnmark County about 40% of catches had origin of salmon rivers of the Western Finnmark area. The River Tana stocks made 17-18%, Russian stocks made 16-18% and salmon stocks from East Finnmark made 11-14% of the official salmon catches. Salmon stocks from Troms County made 7% and stocks from Nordland County have minimal numbers in catches taken in Finnmark.

38-50% of salmon caught in Troms County originated from Troms rivers. Stocks from West Finnmark had high proportions in Troms County with 27-39%. Salmon stocks from Tana, East Finnmark and Russia did not occur often in the catches in Troms County during the official fishing time because the fishery took place during 4 weeks in July when most of the eastern stocks have passed that area.

Material from Nordland in 2011 was too small to make conclusion on the origin of salmon in the catches during the official fishing time in 3 weeks in July. Data from 2012 indicated that salmon caught in Nordland were mainly from the rivers of Troms County and also from West Finnmark, from Russian rivers and from Nordland rivers.

According to official catch statistics the highest wild salmon catches in 2011 and 2012 were taken in Sør-Varanger municipality, Finnmark. Proportions of wild salmon originating from different reporting groups had remarkable differences in catches between municipalities. Salmon of Russian origin made 65% of the catches taken in Sør-Varanger municipality. Tana salmon made high proportion in the municipality Tana in Tanafjord: 80%. Salmon originating from each reporting group area were caught widely in the outermost coastal areas as well as in inner areas of the fjords. Salmon rivers of West Finnmark were supporting high proportions of wild salmon catches in almost all municipalities in western Finnmark. Salmon stocks from numerous rivers in northern Kola Peninsula in Russia were important resources supporting salmon fishery in eastern Finnmark and especially in Sør-Varanger municipality. Salmon catches taken in the municipalities Vadsø-Nesseby had large proportion of fish from the East Finnmark reporting group. Numerous salmon stocks of the River Tana were supporting largely fisheries in Tanafjord and also in neighboring Gamvik and Berlevåg municipalities.

In Terskiy Bereg of the White Sea 48% of sampled salmon had origin of the Varzuga River and 23% of samples were assigned to the Strelna River. The occurrence of Varzuga salmon was highest in the coastal catches taken in the western part of the fishing area: 89%. Fishing over there began in the autumn time when the Fall run fish started approaching the river. The proportion of Varzuga salmon decreased eastward and it was the lowest in the autumn catches (27%) taken in the eastern areas. A variety of salmon populations (15 stocks) was higher in catches taken in June-July than in the autumn time when salmon from only 6 stocks were found in catches (Prusov et al. 2014).

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